

Appendix O

Major Facilities on the Lower Colorado River

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The following section presents a brief description of the major facilities on the lower Colorado River¹ (LCR). A summary of facility ownership and operators is provided in Table O-1. The facilities are described in a downstream route along the course of the LCR.

Table O-1. List of owner/operators for major facilities along the Lower Colorado River

Facility	Owner	Operator	Powerplant	Diversion
Senator Wash	U.S.	IID	Pumping and generating	None
Laguna	U.S.	IID	None	None
Imperial	U.S.	IID	None	Gravity
Palo Verde	U.S.	PVID	None	Gravity
Headgate Rock	U.S.	U.S.	Low head hydro	Gravity
Parker	U.S.	U.S.	Hydro	— ¹
Davis	U.S.	U.S.	Hydro	None
Hoover	U.S.	U.S.	Hydro	— ²
Morelos	Mexico	Mexico	None	Gravity
Pilot Knob Powerplant	IID	IID	Low head hydro	Min 700 cfs Max 8000 cfs
Siphon Drop Powerplant	U.S.	Yuma Co. Water Users	Low head hydro	Min 350 cfs Max 2000 cfs

Notes: During normal years all water released through the dams is discharged through the power plants if so equipped within the capacity of the power plant. Otherwise it is released through discharge gates or valves. No water goes over the dams during normal years. Hoover Dam is equipped with a Pelton wheel generator for system power and startup. All other generators and pumps are turbine type.

cfs = cubic feet per second.

CRIT = Colorado River Indian tribes.

IID = Imperial Irrigation District.

PVID = Palo Verde Irrigation District.

¹ Metropolitan Water District of Southern California operates the Whitsett pumping plant and the Central Arizona Project operates the Havasu Pumping Plant from the lake behind Parker Dam.

² Southern Nevada operates pumped diversion from Lake Mead.

¹ Adopted from Appendix D, "Description and Assessment of Operations, Maintenance, and Sensitive Species of the Lower Colorado River, August 1996."

O.1 Glen Canyon Dam

Glen Canyon Dam, which created the reservoir Lake Powell, was completed in 1963 as a principal part of the Colorado River Storage Project. It is a concrete arch dam 710 feet high and 1,560 feet wide. The maximum generating discharge capacity is 33,200 cubic feet per second (cfs) which may be augmented by an additional 15,000 cfs through the river outlet works. The active capacity of Lake Powell is 20,876,000 acre-feet. Lake Powell has no legislated flood control space. The required system flood control space is allocated among elected project reservoirs including Lake Powell, to augment the 1.5 million acre-feet (maf) required to be available in Lake Mead.

The filling of Lake Powell occurred from 1963 through 1980, during which time all releases of water in the LCR system were in response to downstream demands and other consumptive uses.

O.2 Hoover Dam

Hoover Dam was authorized under the Boulder Canyon Project Act. The dam was constructed in the Black Canyon of the Colorado River about 36 miles from Las Vegas, Nevada. Construction began in 1931 and was completed in 1935.

Hoover Dam was a pioneering structure for providing multiple-purpose water resource functions. The dam controls floods; stores water for irrigation, municipal, and industrial uses in three states; and generates hydroelectric power.

Prior to construction of the dam, the Colorado River downstream was characterized by recurring cycles of flooding in the spring and drought during the summer and fall, which caused damage to crops and nearby property. Flows ranged from an estimated maximum of 300,000 cfs on July 8, 1884, to a low of 700 cfs recorded on December 28, 1924, with a recorded average flow of nearly 15,570 cfs prior to the construction of Hoover Dam.

The dam impounds Lake Mead where water can be stored to a maximum conservation pool of about 27 maf at elevation 1,221.4 feet above msl, and backs water upstream approximately 115 miles creating a surface area of about 163,000 acres at elevation 1,229 feet. The dam is 726 feet high and the water depth is approximately 590 feet. During a “normal” water year, 9 maf of water is released from the dam for U.S. entitlement holders and 1944 Water Treaty water for Mexico. See discussion in Chapter 2 of the LCR MSCP Biological Assessment.

The dam is a major source of power generation in the southwest. The power plant generating capacity is approximately 2,080,000 kilowatts (kW) with maximum release at approximately 49,000 cfs. The spillways have a maximum release capacity of about 400,000 cfs at 1,232 feet with the drum gates in a closed position. This provides a total release capacity of 449,000 cfs. Flood storage of 1.5 maf is located between elevation 1,219.6 and 1,229 feet.

O.3 Davis Dam

The Davis Dam and Powerplant facility was constructed by Reclamation in Pyramid Canyon, 67 miles downstream from Hoover Dam. The site is 10 miles north of the point where Arizona, Nevada, and California meet, and approximately 2 miles upstream from Laughlin, Nevada, and Bullhead City, Arizona.

Completed in 1953, Davis Dam is an earth and rock-fill embankment with a concrete spillway, gravity structure, intake structure, and power plant. The dam's primary purpose is to re-regulate Hoover Dam releases so that they meet downstream demand, including the annual delivery of 1.5 maf of water to Mexico. This is in accordance with the 1944 Water Treaty.

Located on the Arizona side of the river, the Davis Dam Powerplant is immediately downstream from the dam embankment. The power plant generating capacity is 255,000 kW. The Department of Energy (DOE) markets all of Davis Firm Electric Service's energy and capacity. The forebay is formed by the intake, spillway, and gravity structures.

Lake Mohave lies behind Davis Dam and is bound for most of its length by the steep walls of Pyramid, Eldorado, and Black Canyons. The lake is relatively narrow, not more than 4 miles across at its widest point, but provides significant recreation opportunities and supports the largest extant population of the endangered razorback sucker. Additionally, the lake captures and delays flash flood discharge from the side washes below Hoover Dam.

O.4 Parker Dam

Parker Dam spans the Colorado River between Arizona and California 17 miles northeast of the town of Parker, Arizona. Constructed between 1934 and 1938 by Reclamation, Parker Dam's primary purpose is to provide reservoir storage from which water can be pumped into the Colorado River aqueduct and the Central Arizona Project (CAP) aqueduct. Lake Havasu, the reservoir behind Parker Dam, is about 45 miles long and covers 20,390 acres. It can store 648,000 acre-feet of water. The CAP began pumping water from Lake Havasu in 1985. It has a capacity for delivering water to users in central and southern Arizona.

Parker Dam is one of the deepest dams in the world. Seventy-three percent of its height is below the original riverbed; about 85 feet of the 320 feet of structural height of the dam is visible. The dam's superstructure rises another 62 feet above the roadway across the top of the dam. Parker Powerplant is located on the California side of the Colorado River immediately below the dam. It houses four hydroelectric generating units. The installed generating capacity is 120,000 kW, but due to the high tailrace elevation the generating production is approximately 108,000 kW. Four 22-foot diameter penstocks carry up to 5,500 cfs each, to feed the generating units. Fifty percent of the plants power output is reserved for The Metropolitan Water District of Southern California (Metropolitan) to pump water along the Colorado River aqueduct to the Pacific Coast. The remaining Firm

Electric Service power is marketed by Western Area Power Administration (Western), a DOE agency. Under an agreement between Reclamation and Metropolitan, the latter agency financed almost the entire cost of constructing Parker Dam. Metropolitan's Whitsett Pumping Plant, 2 miles upstream from the dam on Lake Havasu, lifts water from the reservoir into the Colorado River Aqueduct, which can deliver up to one billion gallons per day of Colorado River water to the metropolitan areas in southern California.

O.5 Headgate Rock Dam

Headgate Rock Dam is located on the LCR about 1 mile northeast of the town of Parker, Arizona, and 14 miles below Parker Dam. It was constructed in 1941 as a diversion structure to provide irrigation water to the Colorado River Indian Tribes. A 3-unit, low-head run-of-the-river powerplant was added to the structure in 1992.

The water retained by the dam, Lake Moovalya, extends approximately 10 miles upstream and contributes a stable water surface to the recreational area known as the "Parker Strip." The dam raises the river water level approximately 15 feet, but develops no useable storage. The water releases below Headgate Rock Dam mirror the releases from Parker Dam.

The existing spillway capacity through all 7 gates is 140,000 cfs. The maximum powerplant discharge is 20,000 cfs. The maximum generating capacity of the powerplant is 19.5 megawatts (MW).

O.6 Palo Verde Diversion Dam

The Palo Verde Diversion Dam consists of a concrete, gated structure with an adjacent embankment. Reclamation began construction in 1956 and the dam was completed in 1957, as a permanent replacement for the old Palo Verde rock weir. The dam raises the water levels approximately 12 feet, which is sufficient for the gravity flow needed to provide the water supply to the Palo Verde Valley, including the city of Blythe. The dam has no useable storage even though the backwater from the dam reflects approximately 15 miles upstream. The dam is operated and maintained by the Palo Verde Irrigation District (PVID).

O.7 Imperial Dam

Imperial Dam is located approximately 18 miles northeast of Yuma, Arizona. Construction of Imperial Dam and Desilting works by Reclamation began in January 1936 and was completed in July 1938. The dam was constructed to provide for the diversion of Colorado River water to the Imperial and Coachella Valleys, the Reservation Division of the Yuma Project, and Yuma Valley through the All-American Canal on the west side of the dam; and to the Gila Project and the Yuma Auxiliary Project through the Gila Gravity Main Canal on the east side of the dam.

Imperial Dam raised the water surface above the original river 23 feet to elevation 181 feet. It was designed to provide a maximum diversion of 15,155 cfs for the All-American Canal, 2,200 cfs for the Gila Gravity Main Canal, and was designed to pass a maximum flood of 180,000 cfs.

Imperial Dam created a reservoir that originally had a capacity of 85,000 acre-feet, but, the reservoir quickly filled with sediment, as was anticipated. Intermittent dredging and sluicing operations are required to maintain a small reservoir pool with a capacity of about 1,000 acre-feet to ensure diversions can be made to the All-American Canal and Gila Gravity Main Canal. Desilting works were provided for both the All-American Canal and Gila Gravity Main Canal. Sediment accumulations are sluiced downstream to the Laguna Desilting Basin where the sediment is removed by dredging and disposed of adjacent to the desilting basin.

O.8 Senator Wash Pumping/Generating Plant and Regulating Reservoir

Senator Wash is an off-stream storage facility located approximately 2 miles upstream from Imperial Dam. It was constructed to supplement limited storage behind Imperial Dam and Laguna Dam. When sufficient storage is not available at Imperial and Laguna Dams, Senator Wash is used to regulate excess flows arriving at Imperial Dam to prevent over deliveries to Mexico. This storage also ensures delivery demands can be met when flows arriving at Imperial Dam are less than water user demand.

Construction of Senator Wash began in 1964, with operation beginning January 30, 1966. The reservoir has a capacity of 13,836 acre-feet at elevation 251 feet. Senator Wash water surface elevation varies between 210 feet and 240 feet. Current reservoir restrictions prevent raising the reservoir to elevation 251 feet due to concerns with seepage and high hydraulic pressure under the toe of Senator Wash Dam and along West Squaw Lake Dike. The reservoir elevation fluctuates according to water user demand and flows arriving at Imperial Dam.

O.9 All-American Canal, Pilot Knob and Siphon Drop Powerplants

Construction of the All-American Canal started in 1934 and was completed in 1940. It replaced the Alamo Canal, which was originally constructed in 1900 to provide a source of irrigation water to the Imperial Valley. Diversion of water from the Colorado River into the Alamo Canal was made from a headworks facility located near Pilot Knob. Several problems were associated in making this diversion, including the removal of trash and constant dredging to control sediment. In addition, much of this canal was located in Mexico, and the Mexican government controlled flows in the canal being delivered to the United States.

In 1905, a major flood on the Colorado River washed out the Alamo Canal headworks, and the Colorado River partially changed course. The river flowed into the Salton Sea for nearly two years, inundating approximately 330,000 acres of land in the Imperial Valley. On February 10, 1907, the Southern Pacific Railroad Company was able to force the Colorado River back into its natural channel.

The All-American Canal is approximately 80 miles long and provides irrigation water to over 500,000 acres of land in the Imperial Valley, over 78,000 acres in the Coachella Valley, approximately 15,000 acres in the Reservation Division of the Yuma Project, and over 40,000 acres in the Valley Division of the Yuma Project.

A wasteway was constructed by Imperial Irrigation District (IID) on the All-American Canal at Pilot Knob in 1938, and a power generation facility was added at Pilot Knob off the All-American Canal in 1961. Both facilities are located upstream of Morelos Diversion Dam. The wasteway was constructed to protect the All-American Canal and provide a place to discharge excess water back to the Colorado River, in particular those deriving from side wash inflows or water user cutbacks in Imperial Valley. Pilot Knob Powerplant was constructed to allow generation of power from water deliveries made in satisfaction of the 1944 Water Treaty. Pilot Knob has 55 feet of hydraulic head and can produce up to 33,000 kW of electricity, which is about twice the hydraulic head that was available at Siphon Drop Powerplant. This made it economically feasible to construct Pilot Knob Powerplant under a transferred water agreement with the Yuma County Water Users' Association.

Currently, if Mexico's order at the Northern International Boundary (NIB), less drainage return flows and sediment control flows below Imperial Dam, is greater than or equal to 700 cfs, the water for delivery to Mexico at the NIB is routed through the Pilot Knob Powerplant to generate power. Otherwise this water would have been delivered either below Laguna Dam or through the Siphon Drop Powerplant and California wasteway near Yuma, Arizona. Prior to 1995, water was not transferred to Pilot Knob Powerplant until a flow of 1,000 cfs was available for transfer.

Siphon Drop Power Plant was originally constructed in 1926 on the old Yuma Main Canal. It was developed to generate power from water deliveries made to the Yuma Project through the Yuma Main Canal until 1941, and from water delivered to the Yuma Project and Mexico from 1941 through 1972 by way of the All-American Canal. The original powerplant was shut down in 1972, and a new powerplant was constructed and placed in operation in 1987. It currently operates to develop power from Yuma Project deliveries and deliveries made to Mexico. If Mexico's water order at the NIB, less drainage return flows and sediment control flows below Imperial Dam, is less than 700 cfs, the water is normally routed through the Siphon Drop Powerplant to generate power. Siphon Drop Powerplant requires a minimum flow of 350 cfs to operate and, to the extent possible, this flow is maintained through delivery requirements to Mexico and water ordered for the Valley Division of the Yuma Project.

The Yuma Main Canal wasteway, commonly referred to as the California Wasteway, was constructed in 1912. At the same time, the Colorado River Siphon was constructed under the Colorado River at Yuma, Arizona, to deliver water to the Yuma Valley Division in Arizona. The wasteway was constructed to protect the Yuma Main Canal if excess flows are diverted into the canal or sudden cutbacks in water use in the Yuma Valley occur.

The wasteway allows those excess flows to be diverted back into the Colorado River. Later, after the All-American Canal was constructed a portion of the water delivery to Mexico was routed down the All-American Canal through Siphon Drop Powerplant and the Yuma Main Canal wasteway.

O.10 The Gila Gravity Main Canal

Construction of the Gila Gravity Main Canal occurred between 1936 to 1943. Construction dialogs occurred during World War II. The canal is 20.5 miles in length with two tunnels and has a capacity of 2,200 cfs. It serves approximately 100,000 acres of farmland located in the Wellton-Mohawk Irrigation and Drainage District, the North Gila and South Gila Valleys, the Yuma Mesa Irrigation and Drainage District, and the Unit "B" Auxiliary Project.

The headworks for the Gila Gravity Main Canal is located at Imperial Dam. Since the Gila Project was originally authorized to irrigate 585,000 acres, three diversion outlets were originally provided at Imperial Dam. The acreage to be served by the project was reduced in 1947 to 115,000 acres, so only one outlet and one desilting basin were put into operation. The water delivery from the Gila Gravity Main Canal to the North Gila Canal started in 1943. Water was first diverted from the Gila Gravity Main Canal to the Wellton-Mohawk Division in 1952, and the last of the Wellton-Mohawk Project was completed in 1957. Water diversions to Yuma Mesa started in 1952 and water diversions to the South Gila Valley began around 1965.

O.11 Laguna Dam

Construction of Laguna Dam began in July 1905, and the diversion structure was completed in 1909. Laguna Dam was originally constructed to serve as a diversion structure and desilting works for the Yuma Main Canal on the California side of the Colorado River and for the North Gila Canal on the Arizona side of the Colorado River. The dam raised the water level above the original streambed approximately 13 feet (138 to 151 feet). Laguna Dam passed flows in excess of 180,000 cfs prior to the construction of Hoover Dam.

The Yuma Main Canal served the Yuma Project, which consisted of the Reservation Division in California and the Valley Division in Arizona. The Yuma Project was the first Reclamation Project on the LCR. The dam originally diverted water to approximately 14,700 acres of land in the Reservation Division, over 53,000 acres in the Valley Division and approximately 3,500 acres in the North Gila Valley. In 1941, a turnout was constructed on the All-American Canal at Siphon Drop to supply part of the water for the Yuma Project. In June 1948, the diversion works for the Yuma Main Canal were sealed at Laguna Dam and all of the water for the Yuma Project was delivered through the All-American Canal.

Delivery of water to the North Gila Irrigation District through the Gila Gravity Main Canal was authorized in May of 1953. Diversions into the Gila Gravity Main Canal are

made at Imperial Dam. This ended the need to divert water to North Gila from Laguna Dam, and the Arizona heading for the North Gila Canal was sealed.

Today Laguna Dam serves as a regulating structure for sluicing flows that control sediment below Imperial Dam, and to help store excess flows that arrive at Imperial Dam to prevent over-deliveries to Mexico. Water stored behind Laguna Dam can be used as part of Mexico's water order when less than expected water is available at Imperial Dam to meet water demand by U.S. water users. Laguna Dam also protects the downstream toe of Imperial Dam.

Total storage behind Laguna Dam is currently estimated to be 400 acre-feet. Prior to the 1983, Colorado River flood the capacity was approximately 1,500 acre-feet. Dredging was carried out behind Laguna Dam from the 1950s to the early 1970s, in order to maintain its relatively small storage capacity. Sediment removed from above Laguna Dam was placed directly downstream of the rock-fill weir in the floodplain.

O.12 Morelos Diversion Dam

Morelos Diversion Dam is located approximately 9 miles southwest of Yuma, Arizona. Morelos Diversion Dam was constructed by Mexico beginning in late 1948 and became officially operational on November 8, 1950. Its construction was authorized under Article 12 of the 1944 Water Treaty to provide a diversion for the delivery of Colorado River water to the Mexicali Valley.

Minute No. 242 (Minutes are defined as amendments to the 1944 Water Treaty) provided requirements for deliveries at the NIB and the Southerly International Boundary (SIB) near Yuma and San Luis, Arizona, respectively. Up to 140,000 acre-feet annually of agricultural drainage water can be delivered to Mexico at the SIB. The remaining 1.36 maf of water is to be delivered to Mexico at the NIB annually and diverted at Morelos Diversion Dam to the Mexicali Valley. After the United States Bypass Drain was completed in 1978, the Colorado River channel downstream of Morelos Diversion Dam was normally dry unless flows in excess of Mexico's requirements arrived at the NIB. Such flows occurred from 1979 to 1980, from 1983 to 1988, in 1993, and from 1997 to 1999.

Water in excess of Mexico's water order at the NIB is normally passed through Morelos Diversion Dam, through the Limitrophe Division, and into the original Colorado River Channel downstream. Water in excess of Mexico's water order occurs when surplus or flood releases are made from either the Colorado River system or the Gila River system. Excess water arriving at Mexico may also result from side wash inflows that occur above or below Imperial Dam; from a sudden drop in water user demand; or when insufficient storage is available in Senator Wash, Imperial, or Laguna reservoirs to contain flows arriving from Imperial Dam.

Flows arriving at Morelos Diversion Dam normally range from about 750 to over 3,000 cfs during the year. During 1983, flows in excess of 40,000 cfs arrived at the NIB due to flood control releases on the Colorado River, and in 1993 flows in excess of 25,000 cfs arrived at the NIB due to flooding on the Gila River.

1 Mexico is responsible for the operation and maintenance of Morelos Diversion Dam and
2 associated expenses. Mexico is also responsible for removal/clearing of
3 sediment/vegetation immediately upstream and downstream of the dam pursuant to
4 Minute No. 197 of the 1944 Water Treaty. Minute No. 197 provides for international
5 hydrographic, operational and maintenance activities administered by the International
6 Boundary and Water Commission (IBWC). The international boundary is marked on the
7 structure under the terms of the 1944 Water Treaty. Gauging stations are provided and
8 operated by the United States section of the IBWC on the Colorado River, at the NIB, 4
9 miles downstream of the NIB, and at the SIB. The United States provides monthly
10 groundwater elevations for lands in the United States above and below Morelos
11 Diversion Dam. Sediment sampling at NIB is performed by the United States each
12 month of the year. Mexico is also required to provide river gauges immediately upstream
13 and downstream of Morelos Diversion Dam, stage recorders in the canal immediately
14 downstream of Morelos Diversion Dam, and sediment sampling stations in the canal
15 system. Both countries are required to take annual river cross-sections at various
16 locations.